WHAT IS CLAIMED IS:

- 1 1. A method for manufacturing a semiconductor device
- 2 comprising a metal oxide formed on a semiconductor substrate using
- 3 a chemical vapor deposition method, said method comprising:
- 4 a dual-stage deposition step comprising a first stage for
- 5 introducing a material gas containing a specified metal into a
- 6 reactor in which said semiconductor substrate is placed and a
- 7 second stage for subsequently introducing an oxidizing gas into
- 8 said reactor, and
- 9 wherein said metal oxide film as an oxide of said specified
- 10 metal is formed on said semiconductor substrate, by repeating said
- 11 dual-stage deposition step two or more times.
 - 1 2. The method for manufacturing the semiconductor device
 - 2 according to claim 1, wherein introduction of said material gas
 - 3 is stopped at said second stage.
 - 1 3. The method for manufacturing the semiconductor device
 - 2 according to claim 1, wherein said oxidizing gas to be introduced
 - 3 at said first stage is less than the flow rate of said oxidizing
 - 4 gas to be introduced at said second stage.
 - 1 4. The method for manufacturing the semiconductor device
 - 2 according to claim 1, wherein said material gas contains oxygen,
 - 3 whereby said specified metal is oxidized, even by only said
 - 4 material gas.
 - 1 5. The method for manufacturing the semiconductor device

- 2 according to claim 1, wherein said dual-stage deposition step is
- 3 repeated two to ten times.
- 1 6. The method for manufacturing the semiconductor device
- 2 according to claim 1, wherein in the repetition of said dual-
- 3 stage deposition step, said oxidizing gas is introduced as a
- 4 preliminary step before the primary dual-stage deposition step
- 5 is started.
- 1 7. The method for manufacturing the semiconductor device
 - 2 according to claim 1, wherein in the repetition of said dual-
 - 3 stage deposition step, said second stage in the final dual-stage
 - 4 deposition step is omitted.
 - 1 8. The method for manufacturing the semiconductor device
 - 2 according to claim 1, wherein tantalum, hafnium, or zirconium is
 - 3 used as said specified metal.
 - 1 9. The method for manufacturing the semiconductor device
 - 2 according to claim 8, wherein when using said tantalum as said
 - 3 specified metal, tantalum penta-ethoxide is used as said material
 - 4 gas.
 - 1 10. The method for manufacturing the semiconductor device
 - 2 according to claim 1, wherein as said oxidizing gas, such a gas
 - 3 is used as to contain oxygen, ozone, water, nitrogen oxide, or
 - 4 an oxygen radical.
 - 1 11. The method for manufacturing the semiconductor device

- 2 according to claim 1, wherein duration of said first stage or said
- 3 second stage is set to be longer than a mean residence time, in
- 4 said reactor, of said material gas introduced at said first stage
- 5 or said oxidizing gas introduced at said second stage
- 6 respectively.
- 1 12. A method for manufacturing a semiconductor device
- 2 comprising a capacitor having a lower electrode, an upper
- 3 electrode and a capacitive insulating film between said lower
- 4 electrode and said upper electrode on a semiconductor substrate,
- 5 wherein said capacitive insulating film is formed on said lower
- 6 electrode over said semiconductor substrate using a chemical
- 7 vapor deposition method, said method comprising:
- a lower electrode forming step of forming said lower
- 9 electrode on said semiconductor,
- 10 a dual-stage deposition step comprising a first stage for
- 11 introducing a material gas containing a specified metal into a
- 12 reactor in which said semiconductor substrate is placed and a
- 13 second stage for subsequently introducing an oxidizing gas into
- 14 said reactor, and
- wherein a metal oxide film as an oxide of said specified
- 16 metal is formed on said lower electrode over said semiconductor
- 17 substrate, by repeating said dual-stage deposition step two or
- 18 more times, hereby forming said capacitive insulating film; and
- an upper electrode forming step of forming said upper
- 20 electrode on said capacitive insulating film.
 - 1 13. The method for manufacturing the semiconductor device
 - 2 according to claim 12, wherein introduction of said material gas

- 3 is stopped at said second stage.
- 1 14. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein said oxidizing gas to be introduced
- 3 at said first stage is less than the flow rate of said oxidizing
- 4 gas to be introduced at said second stage.
- 1 15. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein said material gas contains oxygen,
- 3 whereby said specified metal is oxidized, even by only said
- 4 material gas.
- 1 16. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein said dual-stage deposition step
- 3 is repeated two to ten times.
- 1 17. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein in the repetition of said
- 3 dual-stage deposition step, said oxidizing gas is introduced as
- 4 a preliminary step before the primary dual-stage deposition step
- 5 is started.
- 1 18. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein in the repetition of said
- 3 dual-stage deposition step, said second stage in the final
- 4 dual-stage deposition step is omitted.
- 1 19. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein tantalum, hafnium, or zirconium

- 3 is used as said specified metal.
- 1 20. The method for manufacturing the semiconductor device
- 2 according to claim 19, wherein when using said tantalum as said
- 3 specified metal, tantalum penta-ethoxide is used as said material
- 4 gas.
- 1 21. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein as said oxidizing gas, such a gas
- 3 is used as to contain oxygen, ozone, water, nitrogen oxide, or
- 4 an oxygen radical.
- 1 22. The method for manufacturing the semiconductor device
- 2 according to claim12, wherein duration of said first stage or said
- 3 second stage is set to be longer than a mean residence time, in
- 4 said reactor, of said material gas introduced at said first stage
- 5 or said oxidizing gas introduced at said second stage
- 6 respectively.
- 1 23. The method for manufacturing the semiconductor device
- 2 according to claim 12, wherein a surface shape of said lower
- 3 electrode of said capacitor is formed as a three-dimensional
- 4 structure.
- 1 24. The method for manufacturing the semiconductor device
- 2 according to claim 23, wherein said surface shape of said lower
- 3 electrode is formed as a hemispherical silicon grain.
- 1 25. A method for manufacturing a semiconductor device

- 2 comprising a metal oxide formed on a semiconductor substrate using
- 3 a chemical vapor deposition method, said method comprising:
- 4 a dual-stage deposition step comprising a first stage for
- 5 introducing a material gas containing a specified metal into a
- 6 reactor, in which said semiconductor substrate is placed, to form
- 7 said metal oxide film as an oxide of said specified metal on said
- 8 semiconductor substrate, and a second stage for decreasing a flow
- 9 rate of said material gas so as to be below the flow rate thereof
- 10 at said first stage and introducing an oxidizing gas into said
- 11 reactor to expose a surface of said metal oxide film to said
- 12 oxidizing gas, and
- wherein said metal oxide film having a desired thickness
- 14 is formed on said semiconductor substrate, by repeating said
- 15 dual-stage deposition step two or more times.
 - 1 26. The method for manufacturing the semiconductor device
 - 2 according to claim 25, wherein introduction of said material gas
 - 3 is stopped at said second stage.
 - 1 27. The method for manufacturing the semiconductor device
 - 2 according to claim 25, wherein said oxidizing gas to be introduced
 - 3 at said first stage is less than the flow rate of said oxidizing
 - 4 gas to be introduced at said second stage.
 - 1 28. The method for manufacturing the semiconductor device
 - 2 according to claim 25, wherein said material gas contains oxygen,
 - 3 whereby said specified metal is oxidized, even by only said
 - 4 material gas.

- 1 29. The method for manufacturing the semiconductor device
- 2 according to claim 25, wherein said dual-stage deposition step
- 3 is repeated two to ten times.
- 1 30. The method for manufacturing the semiconductor device
- 2 according to claim 25, wherein in the repetition of said
- 3 dual-stage deposition step, said oxidizing gas is introduced as
- 4 a preliminary step before the primary dual-stage deposition step
- 5 is started.
- 1 31. The method for manufacturing the semiconductor device
- 2 according to claim 25, wherein in the repetition of said
- 3 dual-stage deposition step, said second stage in the final
- 4 dual-stage deposition step is omitted.
- 1 32. The method for manufacturing the semiconductor device
- 2 according to claim 25, wherein tantalum, hafnium, or zirconium
- 3 is used as said specified metal.
- 1 33. The method for manufacturing the semiconductor device
- 2 according to claim 32, wherein when using said tantalum as said
- 3 specified metal, tantalum penta-ethoxide is used as said material
- 4 gas.
- 1 34. The method for manufacturing the semiconductor device
- 2 according to claim 25, wherein as said oxidizing gas, such a gas
- 3 is used as to contain oxygen, ozone, water, nitrogen oxide, or
- 4 an oxygen radical.

- 1 35. The method for manufacturing the semiconductor device
- 2 according to claim 26, wherein duration of said first stage or
- 3 said second stage is set to be longer than a mean residence time,
- 4 in said reactor, of said material gas introduced at said first
- 5 stage or said oxidizing gas introduced at said second stage
- 6 respectively.